ELECTRICAL INSTRUMENTS.

Industrial Electrical Measuring Instruments. By Kenelm Edgcumbe. Second edition, revised and enlarged. Pp. xvi+414. (London: Constable and Co., Ltd., 1918.) Price 16*s.* net.

IN the student days of their career the majority of electrical engineers are strongly attracted towards the design and manufacture of large machines. To design a 10,000-h.p. dynamo is found to be easier and far more exciting than to invent some small improvement in a measuring instrument. This is one of the reasons which make it far more difficult to get—for instance—a manager for a telephone factory than for a large machine shop. The former would probably be offered a salary four times as large as the latter, although the latter probably did much better during his college course. It is advisable, therefore, for students to remember that there are certain drawbacks to following what is for the moment the fashionable branch of engineering to the neglect of much more profitable branches.

Mr. Edgcumbe's wide experience in the manufacturing and testing of instruments admirably qualifies him for his task. Although there have been no great changes introduced in the types of instruments used since the first edition was published, yet the continuous developments that have taken place have made it necessary to rewrite the whole book. Mathematical reasoning is avoided so far as possible. One consequence is that the mathematician who studies the work carefully will be tempted to explore for himself numerous practical and interesting problems. On p. 25, for instance, there is a diagram of a volt-ammeter with an ohm scale. Few mathematicians will be able to resist the temptation of finding the equation to, and the properties of, the curves which give the ohm scale. Dials marked in this way are used in the Board of Trade panel on the switchboard of a central station. There is a great demand in America for the analogous instruments which give the volts, amperes, and watts on the same dial face. They are useful in electric motor-cars.

The introductory chapters on "Errors and Accuracy" are most helpful. A diagram (p. 9) is given of a scale where the unavoidable error of observation produces the same percentage inaccuracy at all points of the scale. We take it that if R is the reading and x the distance of the pointer from the unit mark on the scale, then $R=a^x$ gives the law according to which the scale is divided, a being a constant. The divisions on this scale, ordinarily called a logarithmic scale, are obviously much further apart at low readings than at high readings. We were surprised to learn that the definition of the percentage error e "usually adopted in this country" is given by

$$\text{True value}=\text{Reading}\ (1+e/100).$$

We should have thought that the academic definition

$$\text{Reading}=\text{True value}\ (1-e/100)$$

was more widely used.

Amongst the instruments described are all types of ammeters, voltmeters, wattmeters, frequency tellers, synchronising devices, recording instruments, speed indicators, oscillographs, pyrometers, relays, rail-bond testers, etc. Descriptions are also given of meggers, ohmers, ducters, graphers, etc. These names are not schoolboy slang, but are in everyday use by engineers. In the old days anyone who could talk about an "earth" or a "short-circuit" might rank as an electrician; now he must be able to define the meaning of quaint phrases like "milking booster."

On p. 384, when describing instruments for testing lightning conductors, the author says that the earth should on no account exceed 10 ohms. Is there any reason why the number 10 should be chosen rather than, say, 1 or 100? The present writer once measured the earth resistance of a lightning conductor on a chimney-stack and found it to be 70 ohms. He had the end dug up, and found that the electrician had put a brick instead of the usual copper plate at the end of the conductor. This had been done twenty years previously, but although the stack had been repeatedly struck by lightning, no damage had been done. It would probably have fulfilled its functions equally successfully for another twenty years if the brick had been left undisturbed.

In conclusion, we congratulate the author on the clearness of his descriptions and on the skill with which he exposes the weak points in the design of several well-known instruments. The diagrams are worthy of the highest commendation, and the printing is good. There are a few misprints. The only serious one is on p. 183, where there are two errors in the formula for the electrostatic attraction between two plates. On p. 404 also lines 4 and 5 from the bottom of the page should be interchanged.

A. RUSSELL.

OUR BOOKSHELF.

Modern Engineering Measuring Tools: A Handbook on Measuring and Precision Tools as used in the Modern Tool-room and Engineering Workshop. By Ernest Pull. Pp. viii+115. (London: Crosby Lockwood and Son, 1918.) Price 4*s.* 6*d.* net.

PRIOR to the outbreak of the war there were still a large number of engineering firms in this country which had not adopted systems of precision in the manufacture of component parts. War conditions have altered this so far that there must be very few firms now which have had no experience in precision methods. It is to be hoped that there will be no retrogression in this important matter now that the war is practically over.

This book is intended to help workmen to acquire a practical acquaintance with the construction and use of the commoner types of measuring appliances as employed in tool-rooms and engineering workshops. It includes sections dealing with the use of micrometers, verniers, various special appliances such as depth-gauges, screw-thread micrometers, etc., gauges and gauge systems, and

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types of measuring machines. The sections dealing with micrometers and verniers are arranged in a specially helpful manner, and contain many diagrams showing the instruments set to various readings, including those cases which present difficulties to beginners. There is also a good description of the Johansson system of standard gauges and the methods of using these gauges, and there is sufficient matter included on the subjects of limits, tolerance, and limit-gauges.

Omissions are inevitable in a small book of this kind, and there are many special appliances developed during the war which do not find a place. The success which the author has attained in this and his companion book for munition workers should encourage him to undertake a more comprehensive volume in which laboratory as well as workshop methods might find a place.

LETTERS TO THE EDITOR.

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Fuel Economisers.

DR. AITKEN'S letter in NATURE of December 12 calls to my mind some unpublished experiments which I made at the National Physical Laboratory in connection with some work on radiation from surfaces, which entirely bear out his statement that the colour of a hot surface at relatively low temperature has very little influence on the amount of radiation leaving it. This is a conclusion which, *a priori*, one would not consider very probable, yet is actually found.

In a series of experiments the sides of a thin cubical metal canister were painted in panels of varying colour, the interior of the cube being filled with rapidly stirred oil electrically heated. The amount of pure radiation leaving each kind of surface at a series of steady temperatures up to about 200° C. was compared with that coming at the same temperature from a "black body" constituted by a re-entrant tube with appropriate diaphragms. The exterior of the tube was washed by the hot oil. For temperature differences in the region of 100° C. it was found that:—

(1) A bright surface of ordinary tin-plate only gave off an amount of radiation equal to 5–10 per cent. of that from a "black body." The quality of the optical perfection of the surface was of little importance so long as it was bright. A metal surface treated with galvanit of various kinds showed effects of the same order as tin-plate. Burnished copper well cleaned with metal polish gave a lower intrinsic radiation than tin.

(2) A coat of almost any paint, regardless of colour, brings the true radiation up to from 80–90 per cent. of that of a "black body," and a quite thin layer of paper varnish or of celluloid varnish, so thin and transparent as to be almost imperceptible to the eye, applied over the bright metal, has almost the same effect.

(3) A layer of tissue-paper or wallpaper pasted over the bright surface, or a coating of whitening or limewash, shows the same kind of effect in restoring practically the full radiation so long as the coating is thin.

(4) If the surface of the cube be metallised with aluminium paint, the pure radiation is reduced to from 45–55 per cent. of that of a "black body." Much depended, however, on the kind of vehicle used for the aluminium, and different samples of aluminium paint, though giving results similar in appearance to the eye, differ considerably in the effects produced. Bronzing and such-like processes produce intermediate effects.

In some later experiments, with which Mr. Ezer Griffiths was associated, a study was made of the total heat-leaving surfaces, with the view of obtaining some data as to the relative effects of conduction, convection, and radiation in ordinary still air. From these experiments it would appear that in the case of low-pressure steam radiators in the region of 100° C., almost exactly half the heat leaving the vertical surfaces, if these are of an ordinary character or painted in the usual manner, consists of pure radiation, the remainder being the combined effect of conduction and convection. Therefore, if, as is a very common practice, the radiators be metallised by painting with aluminium paint, the amount of heat reaching the middle of a room warmed by such radiators would be lowered to half, or double the amount of heating surface would be required to produce the same radiation effect as if the surface were black or of bare metallic iron. These results certainly have an important bearing upon the practical problems of heat transfer.

In the course of a recent perusal of Leslie's "On Heat" I have been much struck with the fact that many of these things were by no means new to him a hundred years ago. His very suggestive and interesting researches do not appear to be anything like so well known as they certainly deserve.

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December 17.

MY attention has been directed to the note in NATURE of November 28 (p. 249) referring to Prof. C. V. Boys's fuel economisers, and also the letter by Dr. John Aitken in the issue of December 12; and as I devoted some consideration to this question about twenty years ago, a description of the apparatus I then devised for a similar purpose, and the results obtained with it, may be of interest.

In order to heat this house, which is a cold one, and finding that the open fireplace in the hall consumed much fuel with little heating effect, I fixed an open fire-stove in front of the existing fireplace. I then fitted a wrought-iron closed box, 3 ft. high, 2 ft. broad, and 9 in. deep, at the back of the stove in the recess in which the fireplace previously existed.

The chimney of the stove was connected to the box near the top at one side, and an outlet connected to the box on the other side, which was led up the chimney. As this outlet-pipe is much smaller than the existing chimney, an iron plate was fixed across the intervening space so as to block it against the entry of air except through the stove.

This box was divided vertically into two equal compartments by a plate extending from the top to within 6 in. from the bottom, so as to ensure that the hot gases flowed past the internal surfaces of the box and imparted their heat to them. At one side of the box near the bottom was fixed a door in case it should be necessary to remove any soot that may have accumulated in it.

The stove is lighted in the usual manner with a little coal, and a coke-fire is maintained thereafter. The iron box soon becomes heated by the gases issuing from the stove, which without the addition of the box would have passed direct into the chimney, and the air of the room circulating around its external surfaces becomes heated, and that of the hall warmed.

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